FINAL

DRAINAGE PLAN AND REPORT

HOT MIX HEIGHTS DEVELOPMENT

AMENDED PLAT
BARBARICK SUBDIVIISON

EL PASO COUNTY

December 18, 2020

Prepared for

H.W. Diesel Enterprises

Oliver E. Watts, Consulting Engineer, Inc.
Colorado Springs, Colorado

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Celebrating over 41 years in business

December 18, 2020

El Paso County Planning and Community Development
2880 International Circle
Colorado Springs, CO 80910

ATTN: *Jennifer Irvine, P.E.*

SUBJECT: Drainage Plan and Report
Amended Plat Barbarick Subdivision,

Transmitted herewith for your review and approval is the drainage plan and report for The Amended Plat of the Barbarick Subdivision. The purpose of this report is to compute the as-built storm runoffs of the existing Hot Mix Heights development, and assess the capacities of the existing detention ponds, as requested by the Planning and Community Development department.

Please contact me if I may provide any further information.

Oliver E. Watts, Consulting Engineer, Inc.

BY:__________________________
Oliver E. Watts, President

Encl:

Drainage Report 8 pages
Computations, 12 pages
FEMA Panel No. 08041C0535 G
SCS Soils Map and Interpretation Sheet
Backup Information, 4sheets
Drainage Plan, Barbarick Sub. Lotrs 1-4
Drainage Plan, Woodmen View Storage
Drainage Plan, Dwg 18-5223-04

1. ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Oliver E. Watts, Consulting Engineer, Inc.

____

Oliver E. Watts Colo. PE-LS No. 9853 date

2. OWNERS / DEVELOPER'S STATEMENT:

I the owner / developer have read and will comply with all of the requirements specified in this drainage report and plan.

H.W. Diesel Enterprises

By: ____
Hunter Lewis. date
125 S. Chestnut Street
Colorado Springs, CO 80908
(719) 634-0298

3. EL PASO COUNTY:

Filed in accordance with the requirements of the El Paso Land Development Code, Drainage Criteria Manual Volumes 1 and 2, and the Engineering Criteria Manual, as amended.

______________________________ ______________

Jennifer Irvine, P.E., date
County Engineer / ECM Administrator

Conditions:

4. LOCATION AND DESCRIPTION:

The Barbarick Subdivision is located at 8725 Vollmer Road in Section 32, Township 12 South, Range 65 West in El Paso County as shown on the enclosed drainage plan. A drainage plan and report was prepared by this office and approved by the County on November 27, 2007. The subdivision was replatted in 2016 to accommodate revised uses, and a final drainage report was prepared for portions of Lots 1 and 2 and Lots 3 and 4 by Matrix Design Ground, which was approved by the County on June 9, 2016. At that time a trash disposal facility was constructed on Lot 4, and detention ponds were constructed on Lots 3 and 4. These facilities were certified by Matrix on January 16, 2017, which was accepted by the County.

The owner of Lots 1 through 3 has revised the use to include equipment and RV storage and is now applying for a conditional use. During the preliminary review process questions were raised by the County Engineering staff as to the adequacy of the drainage facilities, due to apparent increases in runoff from those computed in the Matrix report. The as-built configuration of the site is shown on the enclosed drainage plan.

The purpose of this report is to address questions raised by the County Engineering staff.

5. FLOOD PLAIN STATEMENT:

This subdivision is not within the limits of a flood plain or flood hazard area, according to FEMA map panel number 08041C0535 G, dated December 7, 2018, a copy of which is enclosed for reference.

6. METHOD AND CRITERIA:

The method used for all computations is that specified in the City-County Drainage Criteria Manual, using the rational method for areas of the size of the development. All computations are enclosed for reference and review.

The soils in the subdivision have been mapped by the local USDA/SCS office, and a soils map and interpretation sheet are enclosed for reference. All soils in this area are of hydrologic groups "A" and "B" within the development area as shown on the drainage plan.

The runoff computations for the area are based on the City-County drainage criteria which included as backup information. As noted by County staff, there are significant differences in these criteria with the runoff criteria used in the Matrix report as follows:

Land Use of Surface Type	% impervious used	
	Matrix Report	City-County Criteria
Greenbelts/ Agriculture	2%	2%
Gravel (packed)	40%	80%
Asphalt Paving	none used	100%
Drives and Walks	90%	90%

Lot 1 and the portion of Lot 2 lying directly to the south remain in their historic condition, consisting of portions of concrete, asphalt and packed gravel paving, some of which has been mixed with salvaged asphalt shavings, a practice commonly employed for durability and reduced dust emissions. This portion of the development is unchanged from our original drainage report and was not addressed in the Matrix report and is not a part of this study.

The remainders of lots 2 and 3 have been totally converted to RC storage, which drain into the two existing detention ponds, and asphalt shavings have been extensively used. This use is also apparent throughout Lot 4 in the original construction of the waste disposal facility. The amount of use was fairly extensive in the dedicated private roadways and circulation area in Lot 4, where 95% impervious cover was assumed. In the remainder of areas used for equipment storage in Lot 4, and RV storage in Lots 2 and 3, the imperious cover was assumed to be 85%. These areas are delineated on the drainage plan.

The result of the revisions to assumed cover, is that the total area draining into the easterly (full-spectrum) detention pond has an estimated 82% impervious cover, as compared to the 57% impervious cover used for the Matrix pond computation.

7. DESCRIPTION OF RUNOFF:

The developed area in Lot 3 has been graded slightly different that that approved Matrix plans, and is shown on the drainage plan. The RV areas basically are graded to drain through parking isles directly to the south and the westerly portion is several feet higher. This results in a slightly smaller area draining into the full spectrum pond (Basin B) and a corresponding larger area into the sand filter pond (Basin A). Some additional area along the easterly boundary is included (Basin C), inluding fill slope on the adjacent subdivision draining into this one. Both detention ponds and the outlet structure was certified as constructed in accordance with the approved plans in accordance with the Matrix letter of Janurayr 16, 2017.

The following is a summary and comparison of runoffs shown on the enclosed drainage plan.

Basin	Runoff in CFS (5-year/100-year)	
	This Report	Matrix Report
A	7.8/23.3	4.1/11.1
B	16.7/33.8	25.7/56.0
C	0.5/3.6	0.2/1.4

Basin A drains into the existing sand filter basin where the maximum water surface elevation will be aproximate elevation 7022.5, approximately two feet below the existing spillway, as shown in the enclosed computations. The underdrains were not apparent during our surveys, nor have they been encountered in the owner's maintenance, however the pond should drain as designed within an acceptable period.

Basin B drains into the full spectrum basin there the computed maximum water surface elevation is approximately 7022.5, which is the as-built elevation of the spillway. Although this results in approximately two feet of freeboard, the westerly portion of the dike is recommended to be raised slightly to elevation 7025.00 to correspond to the easterly crest.

FOUR STEP PROCESS
The following process has been followed to minimize adverse impacts of urbanization

Runoff Reduction: The scope of the development has been minimized consistent with zoning requirements to present the minimum footprint in providing an industrial development. The undisturbed portions are to be landscaped to reduce the impervious percent.

Treat and Slowly Release: The above described sand filter basin and full spectrum pond are to be provided to provide water quality treatment and a reduced rate of discharge from the development.

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Channel Stabilizing: The site will be graded to route the runoff channel over improved street paving installations to provide channel stabilizing in the natural erosive material over the site.
Amended Plat, Barbarick Subdivision
Final Drainage Plan and Report

Discharge from the site will be into unplatted portion of the Sterling Ranch in accordance with the master drainage plan and previous subdivision drainage reports. There will be no adverse affect on downstream developments as a result of this subdivision

Source Controls: This is primarily a storage site, so source control problems will be a minimum. During construction, standard site specific state of the art BMP's will be employed to minimize and mitigate erosive problems.

8. COST ESTIMATE:

Item No.	Description	Quantity	Unit Cost	Cost
1	Detention Pond Fill	760 CY	$ 3.00	$ 2280.00
2	Reseeding, drilled	0.05 ac.	525.00	26.28
	Subtotal Construction Cost			$ 2306.28
	Engineering	10%		230.63
	Total Estimated Cost			$ 2536.91

9. FEES:
The development will occur within an existing subdivision, and fees are therefore not applicable.

10. SUMMARY

The owner of the Hot Mix Heights storage facility substituted an asphlat shaving mixture for lot paving, rather than the proposed compacted gravel that was specified in the approved design drawings, after reportedly obtaning prior approval by the County inspector. This resulted in an increase in drainage runoff from that approved in the subdivision drainage report. The County staff has requested that this revised report be prepared to assess the adequacy of existing drainage facilities, particularly the two detention basins on the property. These basins were certified by the design engineer as being completed in accordance with the approved plans.

Our computations show that the sand filter basin is adequate as it now exists is adequately sized for the computed storm runoff and meets County criteria for this type of installation. The full spectrum pond is likewise adequate, in our opinion, however a relatively minor increase in height of a portion of the existing embankment is recommended in order to provide consistency with the remainder of the embankment.

References

1. City of Colorado Springs Drainage Criteria Manuel, Volumes 1 and 2, May, 2014

2. Final Drainage Report, Woodmen View Storage, Calibre Engineering

3. Final Drainage Report, Barbarick Subdivision, Part of Lots 1 and 2, and Lots 3 and 4, Matrix Design Group, approved June 9, 2016.

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc MIN	I in./hr.		SOIL GRP	DEV. TYPE	C		FLOW 5-ry	FLOW 100-yr	RETURN PERIOD -years-	
		PLANIM READ	ACRES	LENGTH -FT.-	HEIGHT -FT.-								qp -CFS-	qp -CFS-		
UNSTUDIED	A	COGO	0.12	300	16	9.1			A/B	AC	0.838	0.908			5	100
		V-4.41	2.807	+370	18	+1.4				SHAV'S	0.652	0.752				
			0.36							POND	0.08	0.35				
		TOTAL	3.27			10.5	4.0	6.6		MIX	0.596	0.714	7.8	23.3	5	100
	B	COGO	0.854	300	18	22.0			A/B	AC	0.838	0.908				
		V=4.16	0.923	+370	16	+1.5				POND	0.08	035				
			0.158							BLDG	0.72	0.81				
			0.105							CONC	0.90	0.96				
			7.903							SHAV'S	0.652	0.752				
			0.218							GRASS	0.08	0.35				
		TOTAL	10.161			23.5	2.7	4.6		MIX	0.610	0.723	16.7	33.8	5	100
	C	COGO	2.140	300	2%	7.0			A/B	GRASS	0.08	0.35				
				+1480	19	14.5										
						21.5	2.9	4.8					0.5	3.6	5	100

HYDROLOGICAL COMPUTATION – BASIC DATA
PROJ: HOT MIX HEIGHTS BY: O.E. WATTS
RATIONAL METHOD DATE: 12/14/20

OLIVER E. WATTS, CONSULTING ENGINEER, INC.
614 ELKTON DRIVE COLORADO SPRINGS, CO 80907

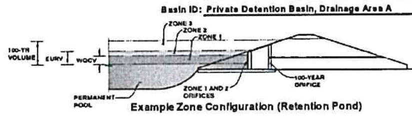
SFB P2-7

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Hot Mix Heights, Amended Barbarick subdivison

Basin ID: Private Detention Basin, Drainage Area A



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF			
Watershed Area =	3.29	acres		
Watershed Length =	670	ft		
Watershed Slope =	0.050	ft/ft		
Watershed Imperviousness =	81.00%	percent		
Percentage Hydrologic Soil Group A =	100.0%	percent		
Percentage Hydrologic Soil Group B =	0.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	12.0	hours		
Location for 1-hr Rainfall Depths =	Denver - Capitol Building			
Water Quality Capture Volume (WQCV) =	0.073	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.351	acre-feet		
2-yr Runoff Volume (P1 = 0.96 in.) =	0.196	acre-feet	0.96	inches
5-yr Runoff Volume (P1 = 1.23 in.) =	0.259	acre-feet	1.23	inches
10-yr Runoff Volume (P1 = 1.48 in.) =	0.322	acre-feet	1.48	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	0.417	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.21 in.) =	0.509	acre-feet	2.21	inches
100-yr Runoff Volume (P1 = 2.57 in.) =	0.611	acre-feet	2.57	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.783	acre-feet		inches
Approximate 2-yr Detention Volume =	0.186	acre-feet		
Approximate 5-yr Detention Volume =	0.246	acre-feet		
Approximate 10-yr Detention Volume =	0.303	acre-feet		
Approximate 25-yr Detention Volume =	0.393	acre-feet		
Approximate 50-yr Detention Volume =	0.456	acre-feet		
Approximate 100-yr Detention Volume =	0.510	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.073	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.436	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.510	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	--	0.00	--	--	--	0	0.000		
	--	1.00	--	--	--	3,692	0.085	1,809	0.042
	--	2.00	--	--	--	4,896	0.112	6,091	0.140
	--	3.00	--	--	--	5,895	0.135	11,535	0.265
	--	4.00	--	--	--	7,059	0.162	18,012	0.414
	--	5.00	--	--	--	8,535	0.196	25,809	0.593
	--	6.00	--	--	--	10,382	0.238	35,268	0.810
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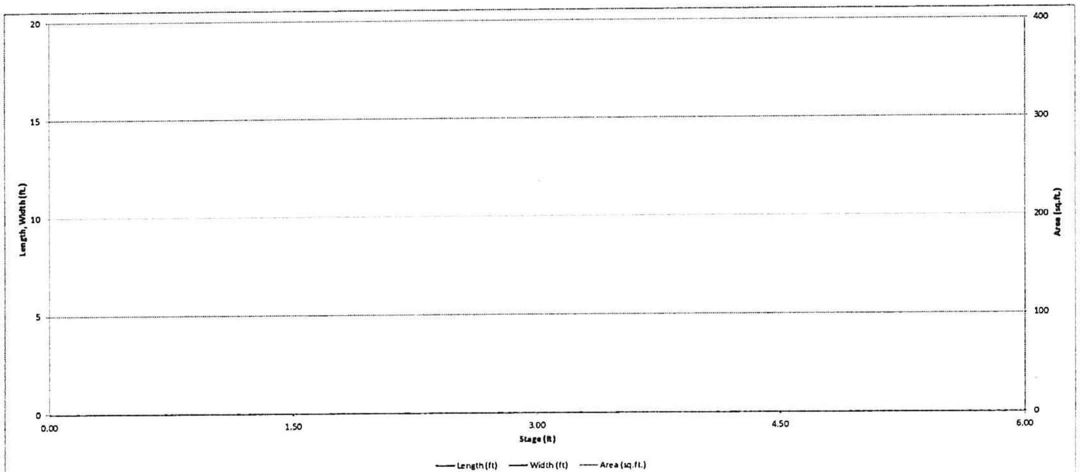
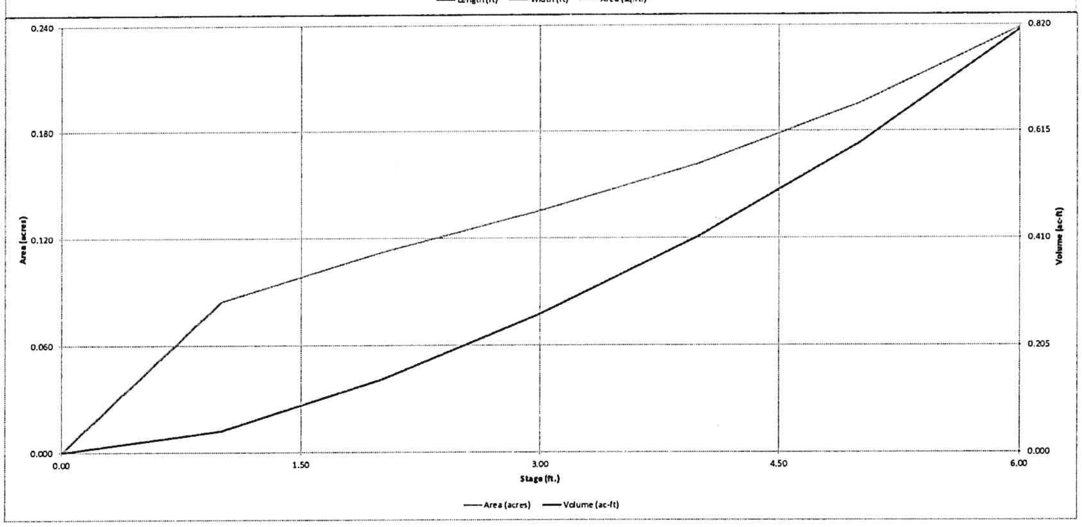
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)





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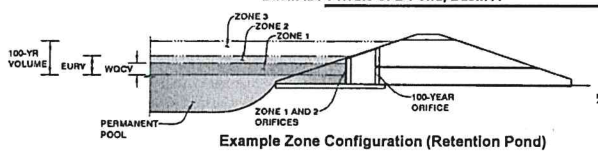
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Hot Mix Development, Amended Barbarick Subdivision

Basin ID: Private SFB Pond, Basin A



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.35	0.073	
Zone 2 (100-year)	4.57	0.436	
Zone 3			
		0.510	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)
Underdrain Orifice Diameter =		inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =		ft^2
Underdrain Orifice Centroid =		feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =		ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =		ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =		inches
Orifice Plate: Orifice Area per Row =		inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (optional)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Slope =			H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =			feet
Overflow Grate Open Area % =			%, grate open area/total area
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Over Flow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			should be ≥ 4
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.60	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =		feet
Spillway End Slopes =		H:V
Freeboard above Max Water Surface =		feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres

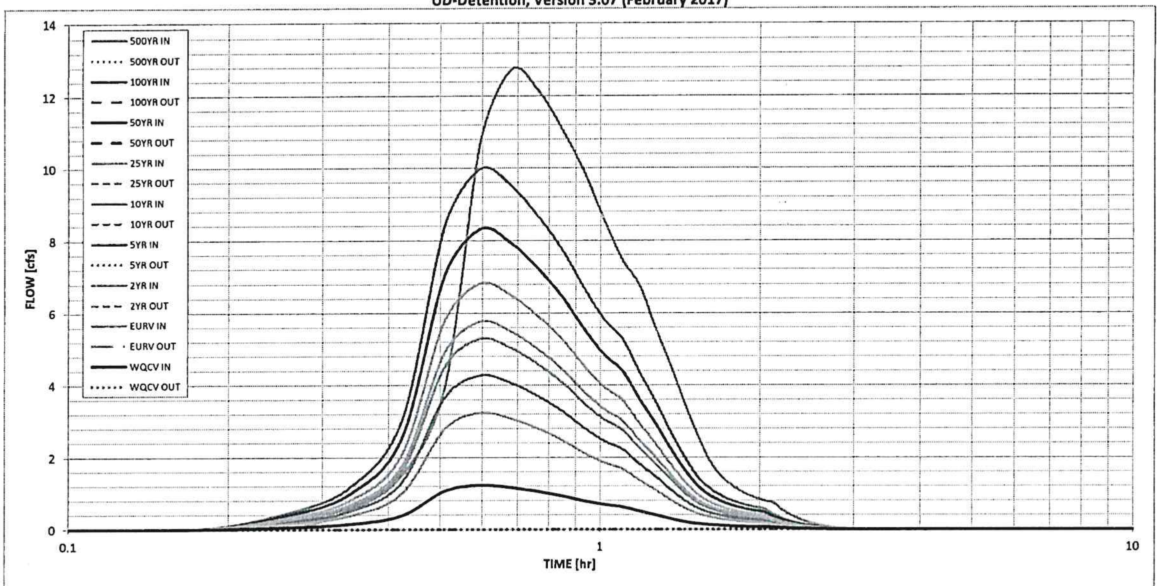
Routed Hydrograph Results

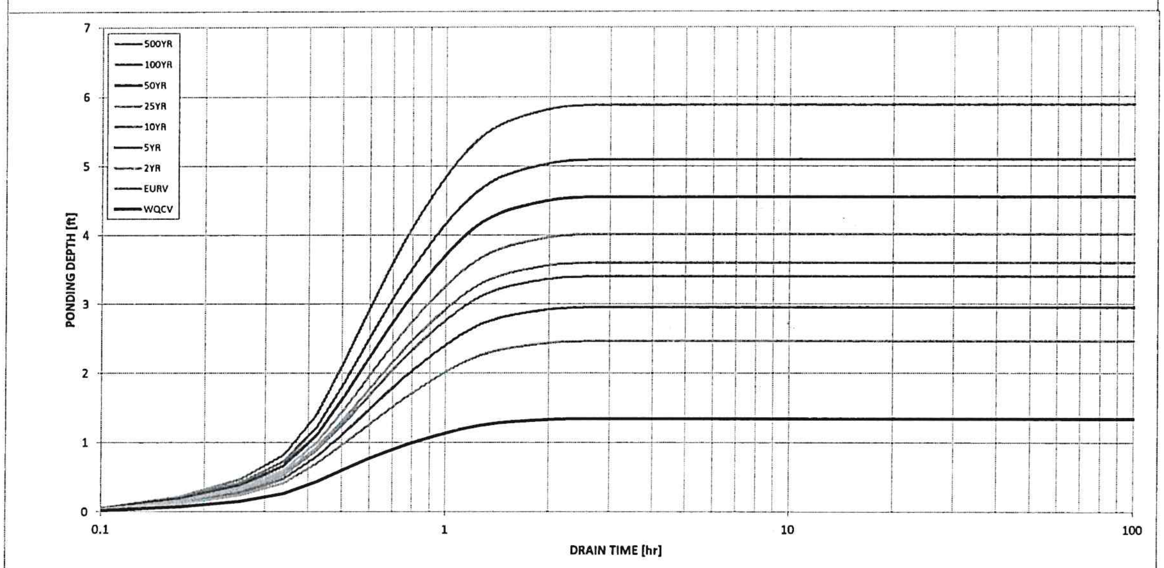
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.96	1.23	1.48	1.85	2.21	2.57	3.14
Calculated Runoff Volume (acre-ft) =	0.073	0.351	0.196	0.259	0.322	0.417	0.509	0.611	0.783
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.073	0.351	0.196	0.259	0.321	0.416	0.508	0.611	0.782
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.02	0.18	0.46	1.03
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.5	3.4
Peak Inflow Q (cfs) =	1.2	5.8	3.2	4.3	5.3	6.8	8.3	10.0	12.7
Peak Outflow Q (cfs) =									
Ratio Peak Outflow to Predevelopment Q =									
Structure Controlling Flow =									
Max Velocity through Grate 1 (fps) =									
Max Velocity through Grate 2 (fps) =									
Time to Drain 97% of Inflow Volume (hours) =									
Time to Drain 99% of Inflow Volume (hours) =									
Maximum Ponding Depth (ft) =									
Area at Maximum Ponding Depth (acres) =									
Maximum Volume Stored (acre-ft) =									

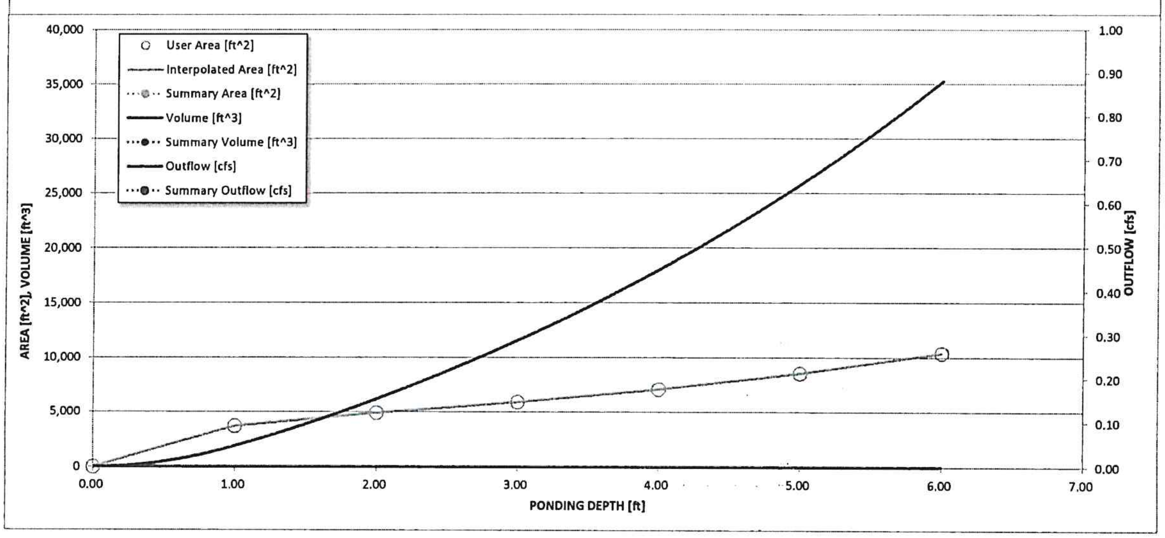
5

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.09 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:10:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:15:16	0.06	0.26	0.15	0.19	0.24	0.31	0.37	0.44	0.56
0.982	0:20:22	0.15	0.69	0.39	0.52	0.64	0.82	1.00	1.19	1.52
	0:25:27	0.39	1.78	1.01	1.32	1.63	2.10	2.56	3.06	3.89
	0:30:32	1.06	4.90	2.77	3.64	4.49	5.78	7.03	8.41	10.70
	0:35:38	1.23	5.77	3.24	4.27	5.29	6.82	8.32	9.97	12.73
	0:40:43	1.16	5.50	3.08	4.07	5.03	6.50	7.93	9.52	12.16
	0:45:49	1.06	5.00	2.80	3.70	4.58	5.91	7.22	8.66	11.07
	0:50:54	0.93	4.45	2.49	3.29	4.08	5.27	6.44	7.74	9.89
	0:55:59	0.79	3.83	2.13	2.82	3.50	4.54	5.55	6.68	8.55
	1:01:05	0.69	3.34	1.86	2.46	3.06	3.96	4.84	5.82	7.45
	1:06:10	0.63	3.03	1.68	2.23	2.77	3.58	4.38	5.27	6.75
	1:11:16	0.50	2.48	1.37	1.82	2.27	2.94	3.61	4.35	5.58
	1:16:21	0.40	2.02	1.11	1.48	1.84	2.39	2.94	3.55	4.56
	1:21:26	0.30	1.54	0.84	1.12	1.40	1.83	2.26	2.73	3.53
	1:26:32	0.21	1.13	0.61	0.82	1.03	1.35	1.67	2.03	2.63
	1:31:37	0.16	0.83	0.45	0.60	0.75	0.98	1.22	1.47	1.90
	1:36:43	0.13	0.64	0.35	0.47	0.59	0.77	0.94	1.14	1.47
	1:41:48	0.10	0.53	0.29	0.39	0.48	0.63	0.78	0.94	1.21
	1:46:53	0.09	0.45	0.25	0.33	0.41	0.54	0.66	0.80	1.03
	1:51:59	0.08	0.40	0.22	0.29	0.36	0.47	0.58	0.70	0.90
	1:57:04	0.07	0.36	0.20	0.26	0.33	0.43	0.52	0.63	0.81
	2:02:10	0.07	0.33	0.18	0.24	0.30	0.39	0.48	0.58	0.75
	2:07:15	0.05	0.24	0.13	0.18	0.22	0.29	0.35	0.43	0.55
	2:12:20	0.04	0.18	0.10	0.13	0.16	0.21	0.26	0.31	0.40
	2:17:26	0.03	0.13	0.07	0.10	0.12	0.15	0.19	0.23	0.30
	2:22:31	0.02	0.10	0.05	0.07	0.09	0.11	0.14	0.17	0.22
	2:27:37	0.01	0.07	0.04	0.05	0.06	0.08	0.10	0.12	0.16
	2:32:42	0.01	0.05	0.03	0.03	0.04	0.06	0.07	0.09	0.11
	2:37:47	0.01	0.03	0.02	0.02	0.03	0.04	0.05	0.06	0.08
	2:42:53	0.00	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.05
	2:47:58	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
	2:53:04	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	2:58:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:03:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:08:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:13:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:18:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:23:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:28:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:33:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:38:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:43:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:49:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:54:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:59:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:04:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:09:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:14:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:19:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:24:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:29:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:34:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:39:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:41:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:46:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:51:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:56:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:01:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:06:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

8

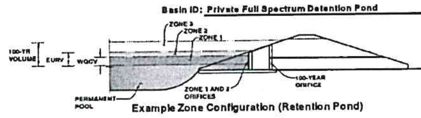
EDB P 8.12

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **Hot Mix Heights**

Basin ID: **Private Full Spectrum Detention Pond**



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB			
Watershed Area =	10.16	acres		
Watershed Length =	670	ft		
Watershed Slope =	0.051	ft/ft		
Watershed Imperviousness =	82.00%	percent		
Percentage Hydrologic Soil Group A =	31.0%	percent		
Percentage Hydrologic Soil Group B =	69.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	Denver - Capitol Building			
Water Quality Capture Volume (WQCV) =	0.289	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.981	acre-feet		
2-yr Runoff Volume (P1 = 0.95 in.) =	0.621	acre-feet	0.95	inches
5-yr Runoff Volume (P1 = 1.23 in.) =	0.835	acre-feet	1.23	inches
10-yr Runoff Volume (P1 = 1.48 in.) =	1.054	acre-feet	1.48	inches
25-yr Runoff Volume (P1 = 1.83 in.) =	1.371	acre-feet	1.83	inches
50-yr Runoff Volume (P1 = 2.21 in.) =	1.675	acre-feet	2.21	inches
100-yr Runoff Volume (P1 = 2.57 in.) =	2.011	acre-feet	2.57	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.551	acre-feet		inches
Approximate 2-yr Detention Volume =	0.585	acre-feet		
Approximate 5-yr Detention Volume =	0.787	acre-feet		
Approximate 10-yr Detention Volume =	0.994	acre-feet		
Approximate 25-yr Detention Volume =	1.189	acre-feet		
Approximate 50-yr Detention Volume =	1.347	acre-feet		
Approximate 100-yr Detention Volume =	1.481	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.289	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.693	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.981	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Total detention volume is less than 100-year volume.

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
	--	1.00	--	--	--	3,625	0.083	1,776	0.041
	--	2.00	--	--	--	8,293	0.190	7,689	0.177
	--	3.00	--	--	--	16,569	0.380	20,202	0.464
	--	4.00	--	--	--	20,098	0.461	38,536	0.885
	--	5.00	--	--	--	23,393	0.537	60,281	1.384
	--	6.00	--	--	--	27,274	1.977	85,615	1.965
	--	7.00	--	--	--	31,155	0.715	114,829	2.636
	--	8.00	--	--	--	35,034	0.804	147,924	3.396
	--	9.00	--	--	--	39,014	0.896	184,948	4.246
	--	10.00	--	--	--	43,095	0.989	226,002	5.188
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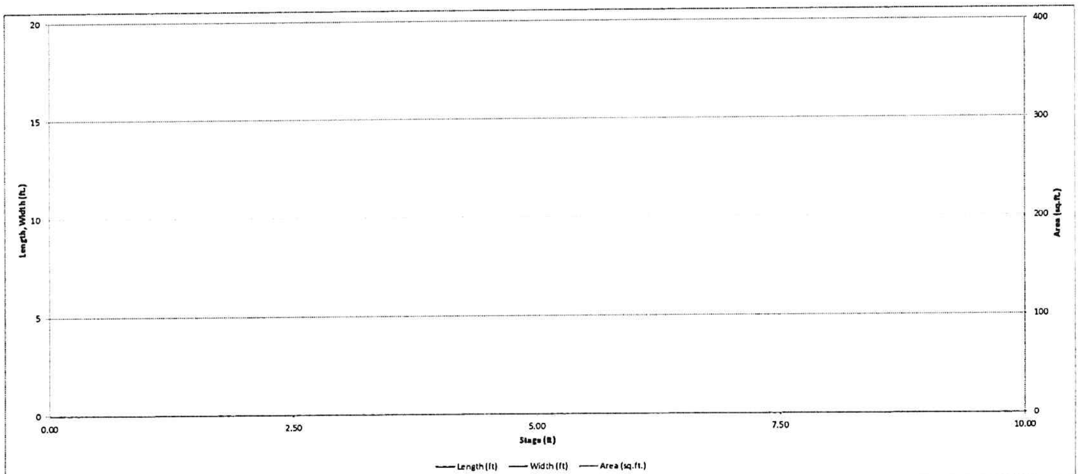
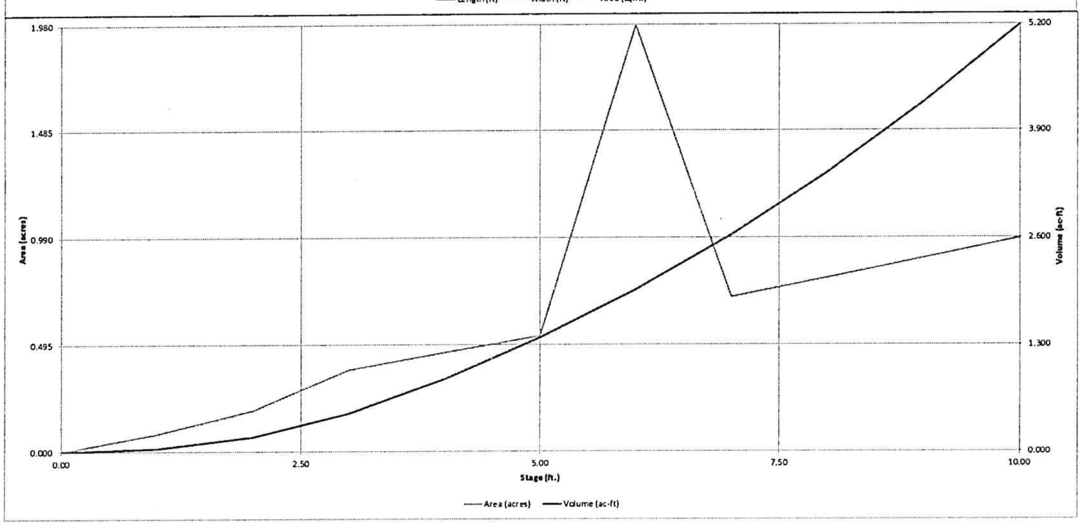
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

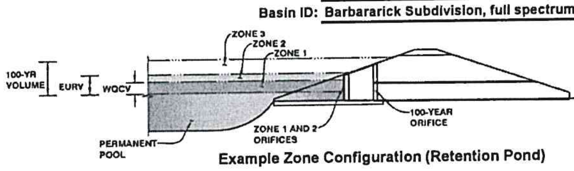




Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Hot Mix Heights
Basin ID: Barbararick Subdivision, full spectrum pond



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.48	0.289	Orifice Plate
Zone 2 (2-year)	3.31	0.296	
Zone 3 (5-year)	3.79	0.202	
		0.787	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.48	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft²

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.00	2.00					
Orifice Area (sq. inches)	1.55	1.55	3.80					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft²
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.20		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.00		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.50		feet
Overflow Grate Open Area % =	70%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =	3.20		feet
Over Flow Weir Slope Length =	3.50		feet
Grate Open Area / 100-yr Orifice Area =	9.33		should be ≥ 4
Overflow Grate Open Area w/o Debris =	14.70		ft²
Overflow Grate Open Area w/ Debris =	7.35		ft²

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =	1.20		ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	17.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =	1.58		ft²
Outlet Orifice Centroid =	0.71		feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	6.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	23.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

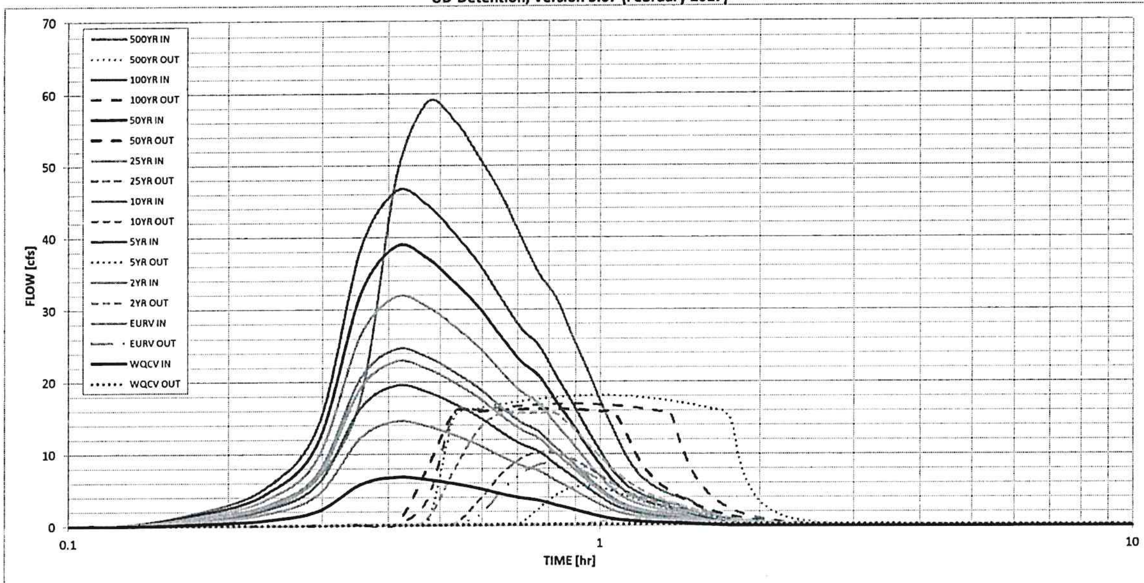
Spillway Design Flow Depth=	0.00	feet
Stage at Top of Freeboard =	7.00	feet
Basin Area at Top of Freeboard =	0.63	acres

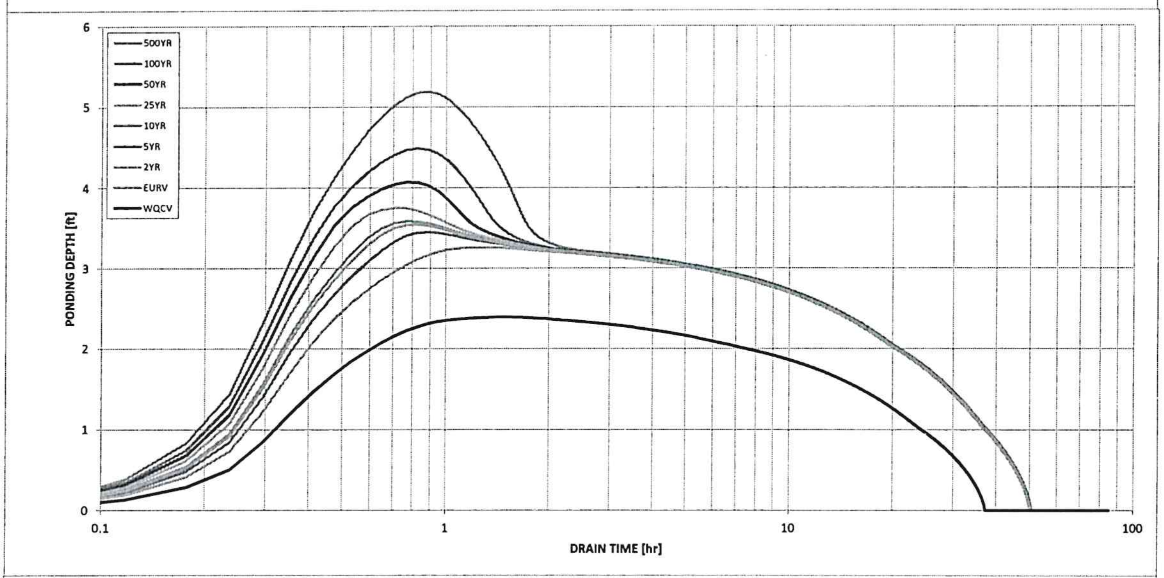
Routed Hydrograph Results

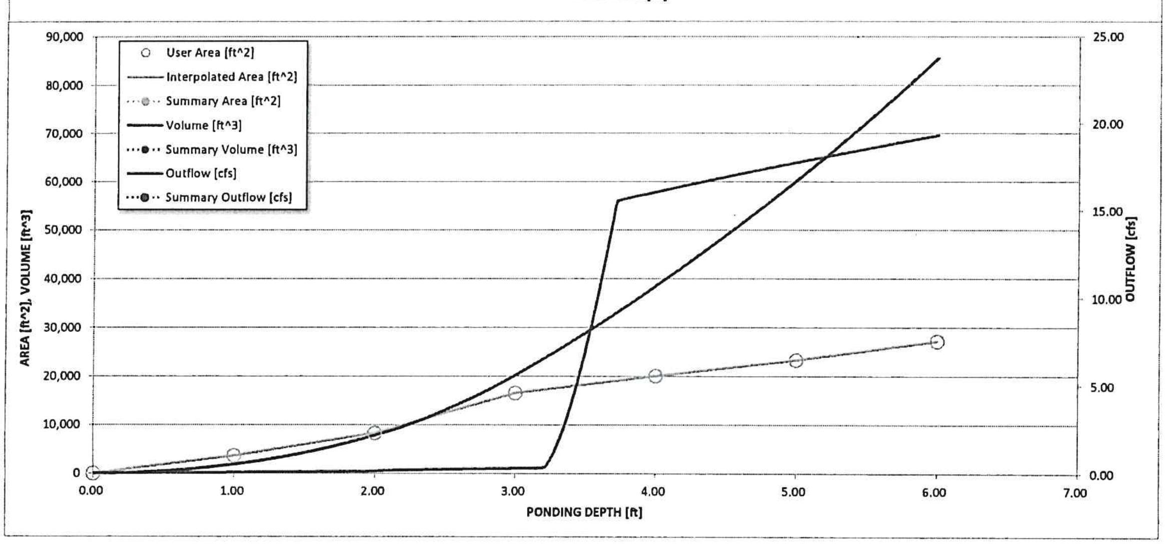
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.95	1.23	1.48	1.83	2.21	2.57	3.14
Calculated Runoff Volume (acre-ft) =	0.289	0.981	0.621	0.835	1.054	1.371	1.675	2.011	2.551
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.289	0.981	0.621	0.833	1.053	1.370	1.674	2.009	2.549
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.19	0.62	1.00	1.48	2.28
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.2	1.9	6.3	10.1	15.0	23.2
Peak Inflow Q (cfs) =	6.8	22.9	14.6	19.5	24.6	31.8	38.8	46.5	58.8
Peak Outflow Q (cfs) =	0.2	8.7	1.0	5.6	10.3	15.6	16.2	16.9	18.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	28.1	5.4	2.5	1.6	1.1	0.8
Structure Controlling Flow =	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	0.58	0.04	0.3	0.7	1.0	1.1	1.1	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	33	40	43	41	40	38	36	34	32
Time to Drain 99% of Inflow Volume (hours) =	36	46	47	46	46	45	44	43	42
Maximum Ponding Depth (ft) =	2.39	3.55	3.26	3.45	3.59	3.75	4.07	4.49	5.19
Area at Maximum Ponding Depth (acres) =	0.26	0.42	0.40	0.42	0.43	0.44	0.47	0.50	0.55
Maximum Volume Stored (acre-ft) =	0.267	0.681	0.565	0.643	0.698	0.772	0.917	1.120	1.482

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
3.54 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:03:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:07:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:10:37	0.31	1.00	0.65	0.86	1.08	1.38	1.68	2.00	2.51
1.412	0:14:10	0.82	2.72	1.74	2.32	2.91	3.76	4.57	5.46	6.87
	0:17:42	2.12	6.98	4.47	5.96	7.48	9.66	11.74	14.02	17.65
	0:21:14	5.82	19.17	12.27	16.36	20.55	26.53	32.23	38.48	48.43
	0:24:47	6.83	22.89	14.56	19.49	24.56	31.84	38.82	46.49	58.78
	0:28:19	6.51	21.87	13.89	18.61	23.48	30.45	37.15	44.52	56.34
	0:31:52	5.92	19.92	12.65	16.95	21.37	27.72	33.82	40.52	51.27
	0:35:24	5.26	17.82	11.29	15.15	19.13	24.85	30.34	36.38	46.09
	0:38:56	4.52	15.43	9.75	13.10	16.57	21.55	26.34	31.64	40.16
	0:42:29	3.95	13.43	8.50	11.41	14.42	18.74	22.89	27.49	34.96
	0:46:01	3.57	12.17	7.70	10.34	13.07	16.99	20.76	24.92	31.65
	0:49:34	2.92	10.08	6.35	8.55	10.84	14.12	17.28	20.78	26.43
	0:53:06	2.37	8.27	5.18	7.00	8.89	11.61	14.23	17.14	21.83
	0:56:38	1.80	6.41	3.99	5.41	6.90	9.05	11.13	13.44	17.18
	1:00:11	1.32	4.81	2.97	4.05	5.19	6.84	8.45	10.24	13.16
	1:03:43	0.97	3.48	2.15	2.92	3.76	4.99	6.19	7.54	9.73
	1:07:16	0.75	2.68	1.67	2.26	2.89	3.82	4.72	5.72	7.35
	1:10:48	0.62	2.20	1.37	1.86	2.37	3.12	3.85	4.65	5.96
	1:14:20	0.53	1.86	1.16	1.58	2.01	2.64	3.25	3.93	5.03
	1:17:53	0.47	1.63	1.02	1.38	1.76	2.31	2.84	3.43	4.39
	1:21:25	0.42	1.47	0.92	1.24	1.58	2.08	2.55	3.08	3.93
	1:24:58	0.39	1.35	0.85	1.15	1.46	1.91	2.34	2.83	3.60
	1:28:30	0.29	0.99	0.62	0.84	1.07	1.40	1.73	2.09	2.67
	1:32:02	0.21	0.73	0.46	0.62	0.78	1.03	1.26	1.52	1.94
	1:35:35	0.15	0.53	0.34	0.45	0.58	0.75	0.93	1.12	1.43
	1:39:07	0.11	0.39	0.25	0.33	0.43	0.56	0.69	0.83	1.06
	1:42:40	0.08	0.28	0.18	0.24	0.31	0.40	0.50	0.60	0.77
	1:46:12	0.06	0.20	0.12	0.17	0.22	0.29	0.35	0.43	0.55
	1:49:44	0.04	0.14	0.09	0.12	0.16	0.21	0.26	0.31	0.40
	1:53:17	0.03	0.10	0.06	0.08	0.10	0.14	0.17	0.21	0.28
	1:56:49	0.01	0.06	0.03	0.05	0.06	0.09	0.11	0.13	0.17
	2:00:22	0.01	0.03	0.02	0.02	0.03	0.05	0.06	0.07	0.10
	2:03:54	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04
	2:07:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	2:10:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:14:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:18:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:21:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:25:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:28:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:32:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:39:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:42:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:46:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:49:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:53:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:57:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:04:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:07:37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:11:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:14:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:18:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:21:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:28:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:32:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:39:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:43:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:46:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:53:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:57:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:04:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:07:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:11:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:14:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

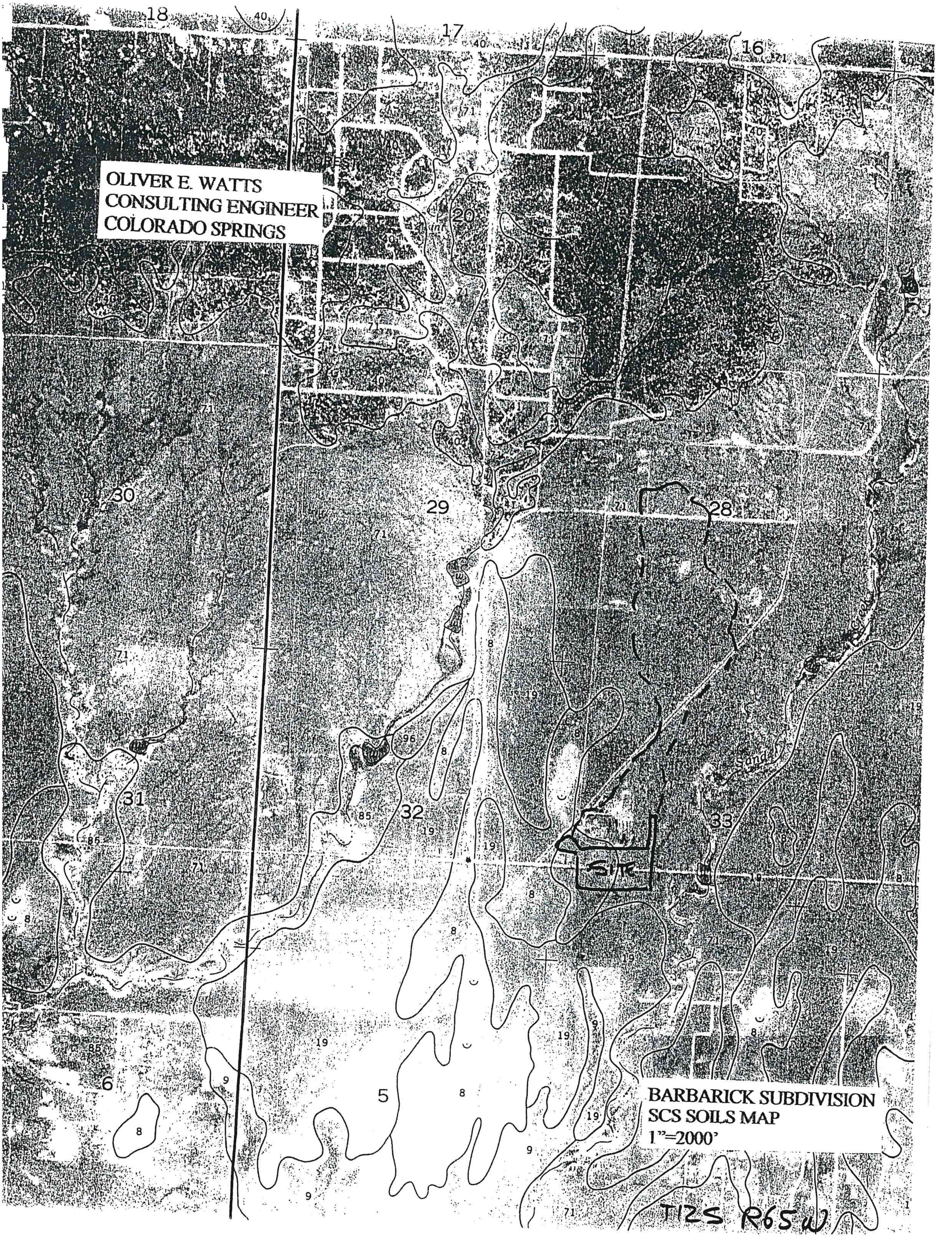

OLIVER E. WATTS
CONSULTING ENGINEER
COLORADO SPRINGS
BARBARICK SUBDIVISION
SCS SOILS MAP
1"=2000'
SITE
T12S R65W

TABLE 16.--SOIL AND WATER FEATURES

ce of an entry indicates the feature is not a concern. See "flooding" in Glossary for definition of erms as "rare," "brief," and "very brief." The symbol > means greater than]

name and symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action
					In		
sa:							
-------------	C	Frequent------	Brief---------	May-Jun	>60	---	High.
on:							
-------------	B	None----------	---	---	>60	---	Moderate.
nd:							
-------------	D	---	---	---	---	---	---
:							
, 7----------	B	None----------	---	---	>60	---	Low.
land:							
-------------	A	None----------	---	---	>60	---	Low.
akeland part-	A	None----------	---	---	>60	---	Low.
uvaquentic aplaquolls art----------	D	Common--------	Very brief----	Mar-Aug	>60	---	High.
on:							
-------------	B	None----------	---	---	>60	---	Moderate.
er:							
12, 13-------	B	None----------	---	---	>60	---	Low.
sett:							
15-----------	B	None----------	---	---	>60	---	Moderate.
eville:							
17-----------	A	None----------	---	---	>60	---	Low.
:							
haseville part	A	None----------	---	---	>60	---	Low.
idway part----	D	None----------	---	---	10-20	Rippable	Moderate.
mbine:							
-------------	A	None to rare	---	---	>60	---	Low.
erton:							
:							
onnerton part-	B	None----------	---	---	>60	---	High.
ock outcrop part----------	D	---	---	---	---	---	---
kton:							
-------------	B	None----------	---	---	>60	---	Moderate.
man:							
23-----------	C	None----------	---	---	20-40	Rippable	Moderate.
:							
Cushman part---	C	None----------	---	---	20-40	Rippable	Moderate.
Cutch part-----	C	None----------	---	---	20-40	Rippable	Moderate.
eth:							
26-----------	B	None----------	---	---	>60	---	Moderate.
7:							
Elbeth part----	B	None----------	---	---	>60	---	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Manvel:							
50	C	None	---	---	>60	---	High.
Manzanola:							
51, 52, 53	C	None to rare	---	---	>60	---	Moderate.
Midway:							
54	D	None	---	---	10-20	Rippable	Moderate.
Nederland:							
55	B	None	---	---	>60	---	Moderate.
Nelson:							
[1]56:							
Nelson part	B	None	---	---	20-40	Rippable	Low.
Tassel part	D	None	---	---	10-20	Rippable	Low.
Neville:							
57	B	None	---	---	>60	---	High.
[1]58:							
Neville part	B	None	---	---	>60	---	High.
Rednun part	C	None	---	---	>60	---	Moderate.
Nunn:							
59	C	None	---	---	>60	---	Moderate.
Olney:							
60, 61	B	None	---	---	>60	---	Moderate.
[1]62:							
Olney part	B	None	---	---	>60	---	Moderate.
Vona part	B	None	---	---	>60	---	Moderate.
Paunsaugunt:							
[1]63:							
Paunsaugunt part	D	None	---	---	10-20	Hard	Moderate.
Rock outcrop part	D	---	---	---	---	---	---
Penrose:							
[1]64:							
Penrose part	D	None	---	---	10-20	Rippable	Low.
Manvel part	C	None	---	---	>60	---	High.
Perrypark:							
65	B	None	---	---	>60	---	Moderate.
Peyton:							
66, 67	B	None	---	---	>60	---	Moderate.
[1]68, [1]69:							
Peyton part	B	None	---	---	>60	---	Moderate.
Pring part	B	None	---	---	>60	---	Moderate.
Pits, gravel:							
70	A	---	---	---	---	---	---
Pring:							
71, 72	B	None	---	---	>60	---	Moderate.
Razor:							
73, 74	C	None	---	---	20-40	Rippable	Moderate.

See footnote at end of table.

National Flood Hazard Layer FIRMette

FEMA

104°41'10"W 38°57'47"N

104°40'32"W 38°57'19"N

1:6,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represen an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/18/2020 at 12:40 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

$$t_c = t_i + t_t$$ (Eq. 6-7)

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ (Eq. 6-8)

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5}$$ (Eq. 6-9)

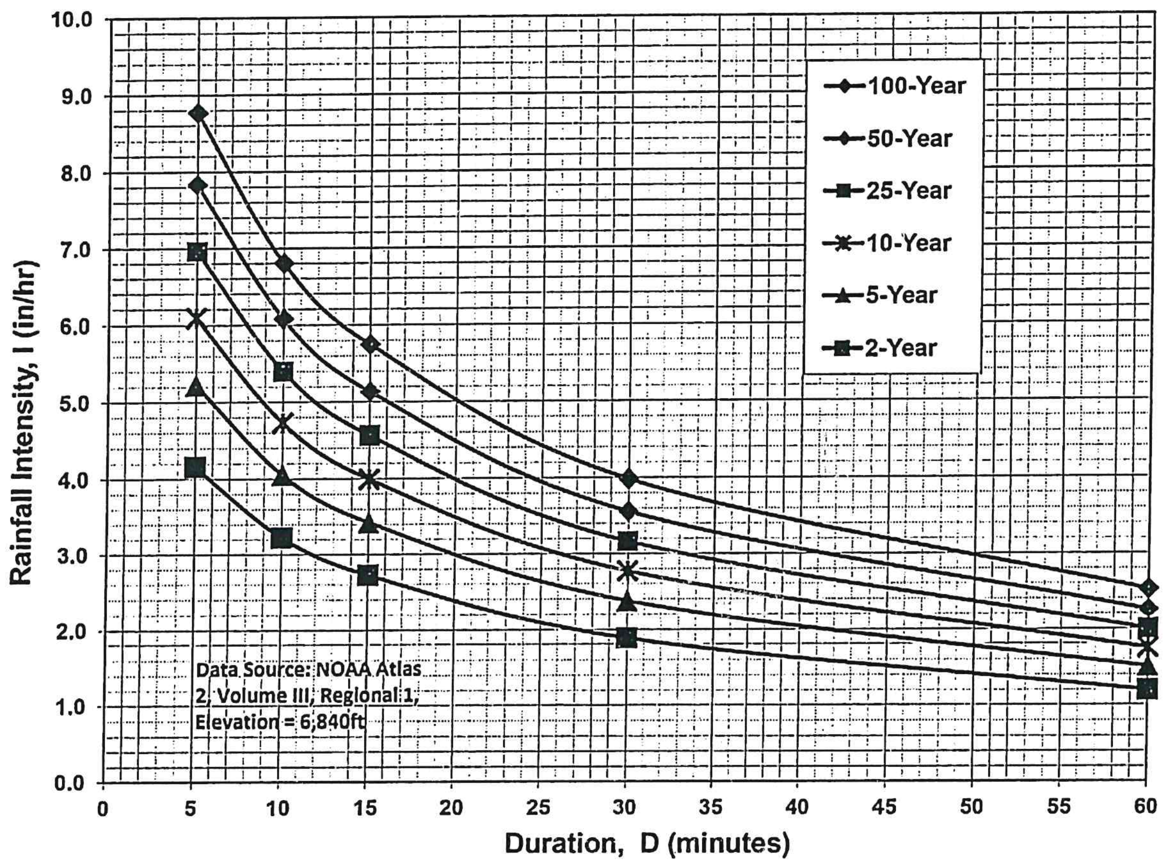
Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

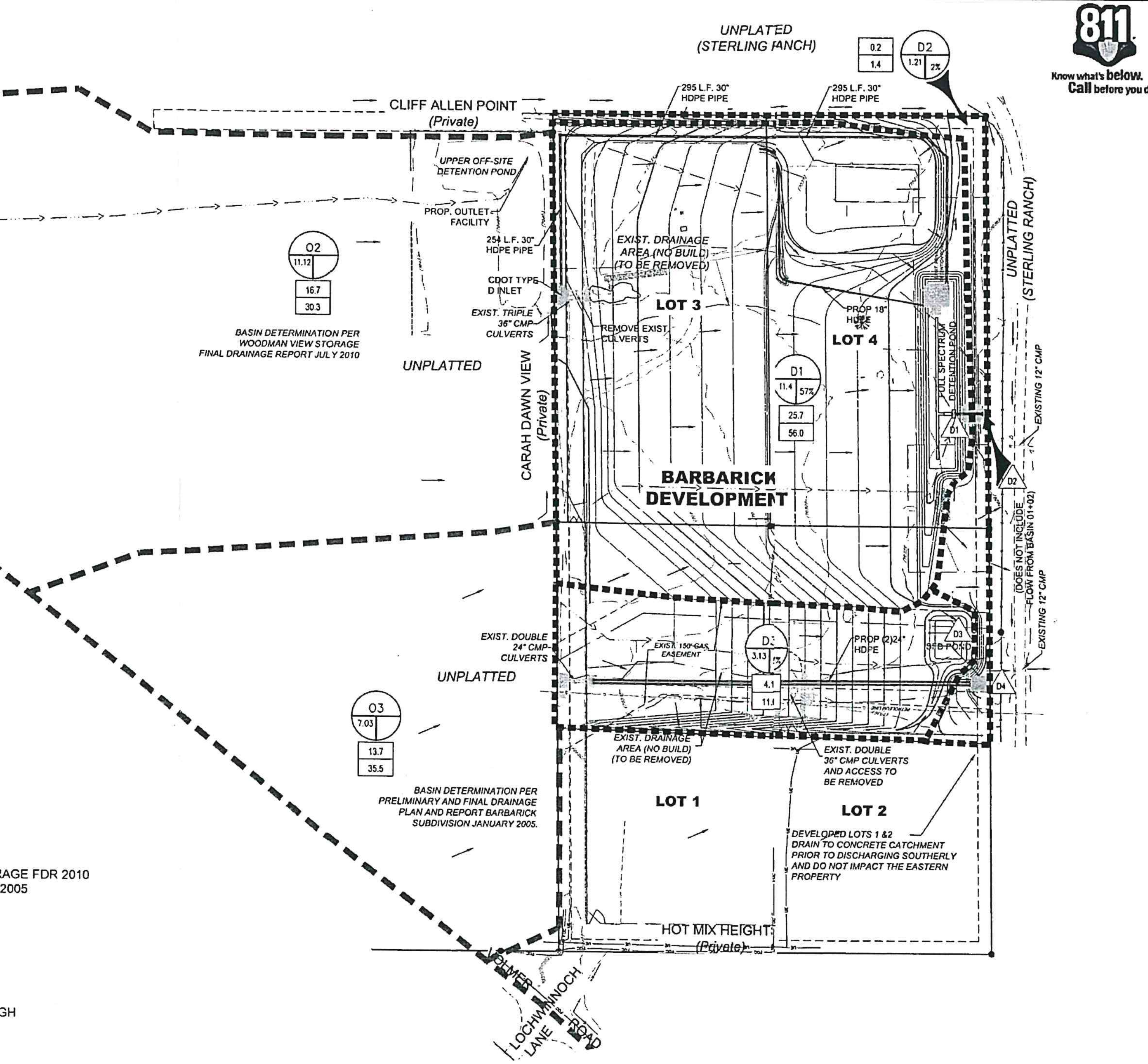
$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

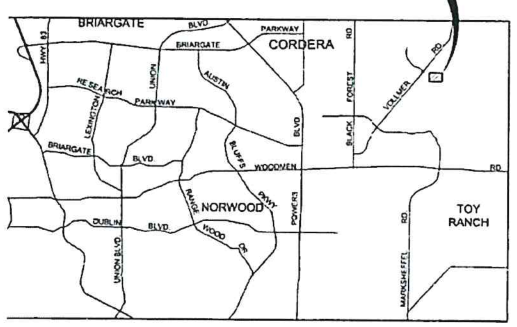
Note: Values calculated by equations may not precisely duplicate values read from figure.



811 Know what's below. Call before you dig.

SCALE IN FEET ORIGINAL SCALE: 100 0 100 200

PROJECT SITE



VICINITY MAP

N.T.S.

SAND FILTER POND
V_{WQ} = 0.039 AC-FT
WQ WSE = 23.37
EURV WC = 0.181
EURV ELEV = 24.52
100-YR WSE = 0.394 AC-FT
100-YR ELEV = 25.83
Q_5 RELEASE = 0.1 CFS
Q_{100} RELEASE = 3.6 CFS

FSD POND
V_{WQ} = 0.203 AC-FT
WQ WSE = 20.03
V_5 = 0.673 AC-FT
5-YR WSE = 21.50
V_{100} = 1.261 AC-FT
100-YR WSE = 22.76
Q_{100} RELEASE = 45.9 CFS
EURV = 0.677 AC-FT
EURV ELEV = 21.50

BARBARICK DRAINAGE SUMMARY TABLE

BASIN	AREA (AC.)	Q(5 (CFS)	Q(100) (CFS)	% IMP.	COMMENT
D1	11.40	25.7	56.0	57%	
D2	1.21	0.8	3.0	2%	HISTORIC
D3	3.13	4.1	11.6	57%	
02	11.12	16.7	30.3		REFF: WOODMAN STORAGE FDR 2010
03	7.03	13.7	35.5		REFF: BARBARICK FDR 2005

DESIGN POINT	AREA (AC.)	Q(100) (CFS)	COMMENT
D1	11.40	85.4	D1 BASIN TO FSD +02 PASS THROUGH
D2	22.52	48.9	POND RELEASE + D2
D3	3.13	11.6	D3 BASIN TO SFB
D4	10.16	39.1	POND RELEASE + O3 PIPE PASS THROUGH

LEGEND

- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PHASE 3A FILING LIMITS
- TEMPORARY DIVERSION SWALE
- LOT LINE
- DESIGN POINT
- SUB BASIN DESIGNATION
- SUB BASIN PERCENT IMPERVIOUS
- SUB BASIN AREA (AC.)
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- PROPOSED FLOW DIRECTION
- EXISTING FLOW DIRECTION

NO.	DATE	DESCRIPTION	BY

REVISIONS

NAME: S:\15.749.001 Tri Lakes\Dwg\CD\Drainage\20160605-DP01.dwg
PCP: Matrix.ctb
PLOT DATE: Tue Jun 07, 2016 12:49pm

BENCHMARK DATA(ELEV.)
(DATUM)
(DESCRIPTION/LOCATION)

VERTICAL BENCHMARK:

THE VERTICAL INFORMATION ON THIS MAP IS BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 AND THE 1960 SUPPLEMENTARY ADJUSTMENT BEING A FOUND 3.25" ALUMINUM CAP IN A ROAD BOX DESIGNATED AS FACILITIES INFORMATION MANAGEMENT SYSTEM (FIMS) MONUMENT "F_69" AND HAVING PUBLISHED ELEVATION OF 6975.62 FEET WAS USED TO REFERENCE THIS VERTICAL DATUM. THE BENCHMARK IS LOCATED ON THE WEST SIDE OF BLACK FOREST ROAD, ABOUT 1.95 MILES SOUTH OF OLD RANCH ROAD, JUST SOUTH OF THE SCHMIDT CONSTRUCTION COMPANY DRIVEWAY. A CORNER FENCE POST IS 28.1 FEET TO THE SOUTHWEST, AND THE MOST SOUTHERLY GUARD RAIL POST IS 25.7 FEET TO THE NORTH.

BASIS OF BEARING:

THE BASIS OF BEARINGS FOR THIS MAP IS THE NORTH LINE OF BARBARICK SUBDIVISION ACCORDING TO THE OFFICIAL MAP THEREOF RECORDED FEBRUARY 12, 2008 IN THE OFFICE OF THE EL PASO COUNTY CLERK AND RECORDER UNDER RECEPTION NUMBER 208712754,SAID LINE MONUMENTED ON THE WEST END BY A FOUND 5/8" REBAR AND ON THE EAST BY A FOUND 4/8" REBAR WITH 1" ALUMINUM CAP STAMPED "LS 2154" BEING A POINT ON THE NORTH LINE BEARING NORTH 89°12'41 EAST 1287.35 FEET FROM THE WEST END THEREOF

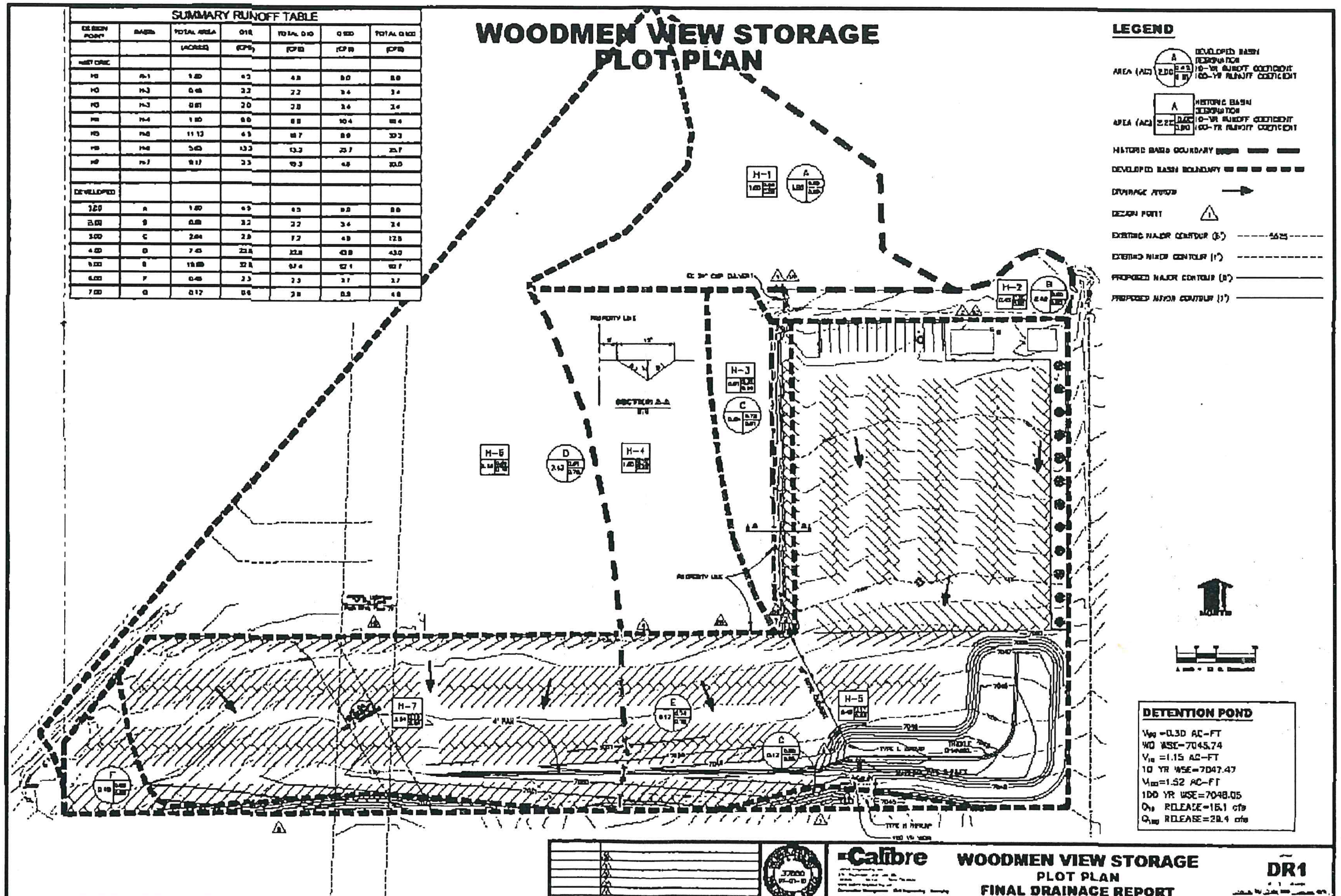
PREPARED UNDER MY DIRECT SUPERVISION, FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.

Matrix DESIGN GROUP
2435 Research Parkway, Suite 300 Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

BARBARICK SUBDIVISION LOTS 1-4

PROPOSED DRAINAGE PLAN

DESIGNED BY: BJH	SCALE	DATE ISSUED: April 2016
DRAWN BY: BJH	HORIZ: 1"=100'	SHEET NO. 1 OF 2 SHEETS
CHECKED BY: ES	VERT: N/A	DP02



Basin Map - from the FDR

DRAWN BY: O.E. WATTS
DATE: 12-15-20
DWG. NO.: 18-5223-04
SURVEYED BY: DEW, ESW THRU 7-18-19
APPROVED BY:
PROJ. NO.
DWG.
REVISIONS

OLIVER E. WATTS
CONSULTING ENGINEER
COLORADO SPRINGS

PROJECT
8815 HOT MIX HEIGHTS
LOT 2, BARBARICK SUB.
EL PASO COUNTY

SHT. NAME
DRAINAGE PLAN

SHT. NO.
1
OF
1